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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/605,442	06/28/2000	Leon R. Barstad	50439-2	5430

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EXAMINER	
WILKINS III, HARRY D	

ART UNIT	PAPER NUMBER
1742	

DATE MAILED: 05/18/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/605,442	BARSTAD ET AL.	
	Examiner	Art Unit	
	Harry D. Wilkins, III	1742	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *29 March 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *124-132 and 134-167* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *124-132 and 134-167* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *28 June 2000* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

1. The rejection grounds based on the Lyde et al teaching are withdrawn in view of Applicant's remarks regarding the fact that Lyde et al is related to a completely different electrolyte chemistry and thus would not have been combinable with the copper sulfate electroplating baths of Dahms.

2. In addition, in further response to Applicant's arguments regarding the suitability of using copper electroplating bath additives from processes that were applied to printed circuit boards for copper electroplating baths for semiconductor wafer chips, the Examiner does not find this argument persuasive. The semiconductor wafer chip electroplating art is replete with examples of baths that use additives that were known from printed circuit board days. For example, Dubin et al (US 5,972,192) describes a copper sulfate electroplating bath that uses "well known" leveling agents, and mentions that they are describe in other patent literature, some of which are related to printed circuit board electroplating. Further evidence can be seen when comparing the disclosures of Uzoh (US 6,117,784) and Bindra et al (US 4,540,473). Please note that the paragraph spanning cols. 3 and 4 in Uzoh is identical to col. 4, lines 34-51 of Bindra et al. This shows that identical electroplating baths could be used for both semiconductor wafer chips (Uzoh) and printed circuitry (Bindra et al).

3. The rejection grounds based on Dubin et al are hereby vacated. Throughout the disclosure of Dubin et al, reference is made to the electroplating bath for the process being the same as the electroplating bath of Sonnenberg et al (US 5,252,196). Sonnenberg et al expressly teach (see col. 8, lines 36-40) that the concentration of the

brighteners is limited to 1 ppm (it is assumed that this is 1 ppm by weight) (which equates directly to 1 mg/L. The preferred amounts of brightener are limited to 500 ppb or less. Therefore, Sonnenberg et al, and, thereby, Dubin et al teach away from increasing the brightener concentration to be at least 1.5 mg/L as is presently claimed.

4. The rejection grounds based on Uzoh are hereby vacated. There appears to be a confusion and inconsistency of terms used between the present disclosure and the disclosure of Uzoh. Uzoh describes using brighteners at 0.5-1.25 wt% made of polyalkylene glycols that may or may not be combined with organic sulfur-containing compounds as multicomponent organic additives. However, the polyalkylene glycols are not brighteners as defined by the present specification and claims. The polyalkylene glycols are the suppressor agent of the present invention. The organic sulfur-containing compounds of Uzoh would correspond to the brighteners of the present invention, but Uzoh is totally silent as to the concentration of those compounds in the electroplating bath. Therefore, it cannot be assumed that Uzoh contains brighteners (as defined by the present specification) at a concentration greater than 1.5 mg/L as is presently claimed.

5. Applicant's remarks regarding the status of claims 138 and 139 are noted. The Examiner inadvertently misstated the status of these claims. They are currently pending.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

8. Claims 124-132 and 134-136 are rejected under 35 U.S.C. 103(a) as being unpatentable over Beach et al (US 4,334,966) in view of Dubin et al (US 5,972,192).

Beach et al teach (see abstract) a method of electroplating copper that includes electrolytically depositing copper from an electroplating bath containing copper sulfate, water, a suppressor agent (polyether) and 1-100 mg/L of a sulfonated, sulfurized benzene compound that behaves as a brightener (see col. 2, lines 41-46). The example given (see example 1) is benzene sulfate disulfide, which possesses a molecular of less than 1000.

Thus, Beach et al fails to teach plating on a semiconductor wafer substrate.

Dubin et al teach (see col. 1, lines 5-40) electroplating copper onto a dielectric silicon layer of a microchip wafer with microvias and trenches.

Therefore, it would have been obvious to one of ordinary skill in the art to have applied the copper electroplating method of Beach et al to the silicon microchip wafer

with microvias and trenches of Dubin et al because the method of Beach et al has good copper electroplating characteristics.

Regarding claim 135, Beach et al teach (see col. 2, lines 47-48) including 20-80 ppm chloride ion.

Regarding claim 136, while Beach et al and Dubin et al do not expressly teach electrically attaching the silicon wafer to the cathode, due to the underlying electrochemical reaction, the wafer is inherently connected to the cathode. This is also shown to be well known in the art by other art of record.

9. Claims 137-139 and 141-156 and 158-159 are rejected under 35 U.S.C. 103(a) as being unpatentable over Beach et al (US 4,334,966) in view of Dubin et al (US 5,972,192) and further in view of Dahms et al (US 3,778,357).

The teachings of Beach et al are described above.

However, Beach et al do not teach that the brightener is a compound having the general formula R'-S-R-SO_3X as is presently claimed. However, Beach et al at least teach using an organic sulfur-containing compound as the brightener.

Dahms et al teach (see abstract, col. 4, lines 5-45 and col. 6, lines 9-20) a preferred embodiment for the electroplating of copper using sodium 3-mercaptopropane-1-sulfonate ($HS(CH_2)_3SO_3Na$) and that the divalent sulfur compound allows for high brightness deposition of copper which is free from haze.

Therefore, it would have been obvious to one of ordinary skill in the art to have used the sodium 3-mercaptopropane-1-sulfonate of Dahms et al for the organic

brightener of Beach et al because Dahms et al teach that the divalent sulfur compound improves brightness and produces a copper electrodeposit free from haze.

10. Claims 137, 140-154 and 157-167are rejected under 35 U.S.C. 103(a) as being unpatentable over Beach et al (US 4,334,966) in view of Dubin et al (US 5,972,192) and further in view of Bernards et al (US 5,051,154).

The teachings of Beach et al are described above.

However, Beach et al do not teach using a sulfonopropyl disulfide compound as the brightener.

Bernards et al teach (see col. 6, lines 29-37) using a bissulfopropyl disulfide as a brightener.

Therefore, it would have been obvious to one of ordinary skill in the art to have used the bissulfopropyl disulfide compound of Bernards et al as the brightener of Beach et al because the bissulfopropyl disulfide is a conventional brightener in copper electroplating that improves throwing power (see col. 5, line 49 to col. 6, line 13, esp. col. 6, lines 5-10) of the electroplating, thus making plating in vias and trenches more even.

11. Claims 137-139, 141-149, 152 and 153 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dahms et al (US 3,778,357) in view of Dubin et al (US 5,972,192).

Dahms et al teach the invention substantially as claimed. Dahms et al teach (see abstract, col. 3. lines 44-55 and col. 4, lines 5-45) a method of electroplating copper onto a substrate including a souble salt of copper (copper sulfate), a source of chloride

ions and a brightener, such as sodium 3-mercaptopropane-1-sulfonate ($HS(CH_2)_3SO_3Na$), at 0.0005 to 0.2 g/L = 0.5-200 mg/L. Thus, Dahms et al teach adding the brightening agent at up to 200 mg/L.

Thus, Dahms et al fails to teach plating on a semiconductor wafer substrate.

Dubin et al teach (see col. 1, lines 5-40) electroplating copper onto a dielectric silicon layer of a microchip wafer with microvias and trenches.

Therefore, it would have been obvious to one of ordinary skill in the art to have applied the copper electroplating method of Dahms et al to the silicon microchip wafer with microvias and trenches of Dubin et al because the method of Dahms et al has improved throwing power (abstract), thus indicating improved ability to evenly fill high aspect ratio surface features such as the microvias and trenches of Dubin et al.

Regarding claims 125-132 and 142-149, Dahms et al teach adding the brightening agent at up to 200 mg/L.

Regarding claims 137-139, Dahms et al teach using 3-mercaptopropane-1-sulfonate, which fits the formula XO_3S-R-SH.

Regarding claim 141, the sodium 3-mercaptopropane-1-sulfonate ($HS(CH_2)_3SO_3Na$) has a molecular weight of 170.

Regarding claims 135 and 152, Dahms et al teach (see col. 4, lines 54-56) adding a source of chloride ions.

Regarding claims 136 and 153, Dahms et al teach (see Example 2) using the substrate as the cathode (i.e.-electrically connected to the cathode).

12. Claims 124-132, 134-136, 150-151, 154-156 and 157-159 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dahms et al (US 3,778,357) in view of Dubin et al (US 5,972,192) and further in view of Bernards et al (US 5,068,013).

The teachings of Dahms et al are described above.

However, Dahms et al do not teach using a suppressor agent, such as a polyether, in the electroplating solution.

Bernards et al teach (see paragraph spanning cols. 2 and 3 and col. 4, lines 31-45) adding a polyether surfactant to a copper plating solution to improve the throwing power of the solution (i.e.-improved even plating in high aspect ratio through holes (see discussion at col. 1, line 29 to col. 2, line 35).

Therefore, it would have been obvious to one of ordinary skill in the art to have added the polyether surfactant as a suppressor agent to the prior art copper plating solutions because Bernards et al teach that the polyether surfactant has the ability to improve even plating in high aspect ratio features.

13. Claims 140 and 160-165 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dahms et al (US 3,778,357) in view of Dubin et al (US 5,972,192) and further in view of Bernards et al (US 5,051,154).

The teachings of Dahms et al are described above.

However, Dahms et al do not teach using a sulfonopropyl disulfide compound as the brightener.

Bernards et al teach (see col. 6, lines 29-37) using a bissulfopropyl disulfide as a brightener.

Therefore, it would have been obvious to one of ordinary skill in the art to have used the bissulfopropyl disulfide compound of Bernards et al as the brightener of Dahms et al because the bissulfopropyl disulfide is a conventional brightener in copper electroplating that improves throwing power (see col. 5, line 49 to col. 6, line 13, esp. col. 6, lines 5-10) of the electroplating, thus making plating in vias and trenches more even.

14. Claims 166 and 167 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dahms et al (US 3,778,357) in view of Dubin et al (US 5,972,192) and Bernards et al (US 5,051,154) and further in view of Bernards et al (US 5,068,013).

The teachings of Dahms et al and Bernards et al '154 are described above.

However, Dahms et al and Bernards et al '154 do not teach using a suppressor agent, such as a polyether, in the electroplating solution.

Bernards et al '013 teach (see paragraph spanning cols. 2 and 3 and col. 4, lines 31-45) adding a polyether surfactant to a copper plating solution to improve the throwing power of the solution (i.e.-improved even plating in high aspect ratio through holes (see discussion at col. 1, line 29 to col. 2, line 35).

Therefore, it would have been obvious to one of ordinary skill in the art to have added the polyether surfactant as a suppressor agent to the prior art copper plating solutions because Bernards et al '013 teach that the polyether surfactant has the ability to improve even plating in high aspect ratio features.

Response to Arguments

15. Applicant's arguments filed 29 March 2005 have been fully considered but they are not persuasive. Applicant argued that Dahms is related to a totally different electrolyte composition because it includes phosphonium ions.

In response, the present claims recite an "electroplating composition that comprises". This means that the electroplating composition is open to other constituents, even including the phosphonium ion source of Dahms. It is noted that the basic chemistry of the electroplating bath of Dahms is still copper sulfate.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Harry D. Wilkins, III whose telephone number is 571-272-1251. The examiner can normally be reached on M-Th 10am-8:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Roy V. King can be reached on 571-272-1244. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Harry D Wilkins, III
Examiner
Art Unit 1742

hdw